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Provides procedures for evaluating the safety of hand and shoulder weapons during development testing. Covers performance tests leading to a safety release (as prescribed in DARCOM-R 385-12 with TECOM Suppl 1) and includes guidance for safety evaluation throughout all phases of development testing. Applicable to rifles, pistols, submachine guns, machine guns, shotguns, and grenade launchers. Excludes pyrotechnic devices.

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U. S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-102
*Test Operations Procedure 3-2-504 1 March 1977
AD No.

SAFETY EVALUATION OF HAND AND SHOULDER WEAPONS

1. SCOPE. This TOP provides procedures for evaluating the safety of hand and shoulder weapons during developmental tests. It covers rifles, pistols, submachine guns, machine guns, shotguns, and grenade launchers but not pyrotechnic devices (TOP/MTP 4-2-131).

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

ITEM	REQUIREMENTS
Firing range	Selected from the small arms firing ranges listed in DARCOM-P 70-1 1/ to suit test requirements
Temperature chamber	To condition test items to temperatures ranging from 160° F (71.1° C) to -60° F (-51.1° C)

1/ DARCOM-P 70-1, DARCOM Test Facilities Register.

*This TOP supersedes MTP 3-2-504, 28 October 1968.

ITEM	REQUIREMENTS
Metal parts security screen	A panel of any suitable material (fiberboard, plywood, etc.) with a hole cut in the center through which the weapon is fired to detect metal parts separated from the projectile. Panel must be sturdy enough to withstand muzzle blast effects while indicating the impact of any separated metal parts.
Witness screen	A panel of material of suitable strength and coloration to detect the impact of particles that may be injurious to the gunner or nearby personnel

2.2 Instrumentation.

ITEM	MAXIMUM ERROR OF MEASUREMENT*
Projectile velocity measuring equipment (TOP 4-2-805)	Velocity to 10,000 fps (3,048 m/s) ±0.1%**
Temperature measuring equipment (e.g., thermocouples and a recorder)	Weapon temperature to ±2° F (±1.1° C)
Magnetic particle inspection equipment (TOP 3-2-807)	Detection of cracks or defects down to 0.01 inch in size
Sound pressure level measuring equipment (TOP/MTP 3-2-811)	±1 db of reading
Headspace gage appropriate for weapon under test	±0.001 inch (±0.0254 mm)
Meteorological equipment:	
Windspeed	0 to 100 mph ±1-3/4 mph (0 to 44.7 m/s ± 0.8 m/s)
Wind direction	360° ±3°
Ambient temperature	-35° to +50° C ±0.2° C
Relative humidity	5% to 100% RH ±1%

*Values may be assumed to represent ±2 standard deviations; thus the stated tolerances should not be exceeded in more than 1 measurement out of 20.

**Lower precision levels may be specified for test firings conducted exclusively to verify normal safe functioning.

3. PREPARATION FOR TEST.

3.1 Planning.

a. Review the safety statement (provided in accordance with DARCOM-R 385-12 and TECOM Suppl 1) [2/] and all previous test reports of similar or related systems. Ascertain, either from the contractor or the appropriate commodity command, whether a proof round has been fired in each test item and the estimated maximum chamber pressure of the proof round.

b. Assemble information on the physical characteristics of the item (TOP/MTP 3-2-500), its method of operation, maintenance requirements, and expected modes and areas of deployment.

c. Based on the above information (a and b), plan a comprehensive testing program to establish the safety of the system including the following essential features:

(1) Preliminary examinations and limited tests necessary to certify, through a safety release in accordance with DARCOM-R 385-12, that the item is safe for further testing. Performance tests appropriate for this phase are described in paragraph 5 below, but special tests should be added if necessary to evaluate the safety of any feature of a specific weapon. If a proof round has not been fired at 130% of the average maximum chamber pressure, this must be included in the testing program.

(2) Selected physical performance and reliability tests to verify that the item under test satisfies minimum design and construction requirements for safe field deployment. Tests required are selected from TOP/MTP 3-2-059, Hand and Shoulder Weapons, based on the purpose and characteristics of the system under test, and may include any or all of the following tests:

Cook-Off	Human factors
Endurance	Mud
Low temperature	Icing
High temperature	Salt water immersion
Fungus	Noise
Water spray	Rough handling
Sand and dust	High humidity-temperature

(3) Systematic observations and analyses of the test system throughout all phases of development testing to identify and investigate any actual or potential hazards to personnel and equipment that may result from operation and maintenance of the system by represenative users.

2/ DARCOM-R 385-12 with TECOM Suppl 1, Life Cycle Verification of Materiel Safety.

3.2 Test Item.

a. Disassemble the test item and visually examine all major components (i.e., safety and trigger mechanisms, locking arrangement, etc.) for conformance with specifications and design drawings. Measure cartridge headspace. Record any deviations from specifications.

b. Conduct a magnetic particle inspection of components to be subjected to the greatest stresses during firing (i.e., bolt, locking lugs, barrel, muzzle device, etc.) as described in TOP/MTP 3-2-807.

c. Calculate the approximate recoil energy of the weapon. The following formula may be used when dealing in US customary units:

$$RE = \frac{W_g}{64.4}\left[\left(W_p \times 1.75 + W_b\right)\frac{MV}{W_g \times 7000}\right]^2$$

where: RE = Recoil energy for the gun (ft-lb).
(for conversion to SI units, multiply by 1.356 to obtain joules)

W_g = Weight of the gun (lb).

W_p = Weight of the propellant (grains).

W_b = Weight of the bullet (grains).

MV = Muzzle velocity of the projectile (fps or m/s) - the highest allowable under commercial specification unless measurements have been made.

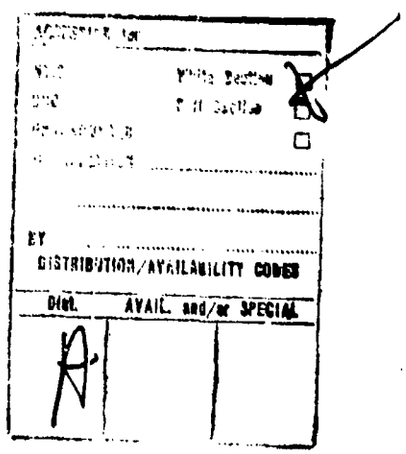
NOTE: If the approximate recoil energy of a test weapon, when calculated in accordance with the above, approaches an unsafe level (approximately 60 ft-lb), or if precise data are needed to evaluate a specific application, the exact recoil energy should be measured using a ballistic pendulum as described in TOP 3-2-826 prior to other test firings.

d. Record the following for the test weapon and its ancillary equipment, as applicable:

(1) Nomenclature, model and serial number.

(2) Manufacturer.

(3) Accessories and tools supplied.



(4) Calculated recoil energy if weapon is a hand-held or shoulder supported item.

(5) Noted material discrepancies.

e. As applicable, record the following for the bayonet, carrying sling, muzzle device, etc:

(1) Location.

(2) Type of attachment.

(3) Any actual or possible interference with the test item performance.

f. Photograph all discrepancies and interferences.

3.4 Ammunition. Insure that a separate safety evaluation, applicable to the weapon under test, has been conducted for all ammunition items in accordance with TOP 4-2-016 if other than standard ammunition is to be used.

3.5 Personnel. Familiarize test personnel with the technical and operational characteristics of the test weapon, as described in the applicable technical manuals, requirements documents, or manufacturer's literature. Review any special warnings or safety statements prepared by the developer before commencing the safety evaluation.

4. TEST CONTROLS.

a. The weapons are tested in the configuration and condition in which they are to be deployed and operated by the field army.

b. The safety evaluation is planned, conducted, and reported by engineering personnel who are occupationally qualified in the specific commodity under test.

c. All precautions necessary to insure the highest feasible degree of safety of test personnel and auxiliary equipment are followed during all phases of the safety evaluation.

d. Preliminary firing trials of hand-held or shoulder-supported weapons are limited as shown in table 1.

e. All range and facility safety SOP's are observed throughout testing.

f. Any failures or hazards identified during any test phase will be corrected and retested before initiation of the next test phase.

Table 1 - Firing Limitations for Test Weapons

Computed Recoil Energy (See para 3.2c)	Limitations on Rounds
Less than 15 ft-lb (20.3 joules)	Unlimited firing
15 to 30 ft-lb (20.3 to 40.7 joules)	200 rounds/day/man
30 to 45 ft-lb (40.7 to 61.0 joules)	100 rounds/day/man
45 to 60 ft-lb (61.0 to 81.4 joules)	25 rounds/day/man
Greater than 60 ft-lb (81.4 joules)	No shoulder firing

5. PERFORMANCE TESTS.

5.1 Preliminary Functional Tests.

5.1.1 Method.

a. Prepare each of one to three test weapons (depending upon the population from which the sample is drawn) for remote firing as follows:

(1) Mount the test weapon to a suitable test stand (or mechanical rest).

(2) If provided, install the bayonet on the test item.

(3) Connect a remote firing mechanism (lanyard or electrical device).

(4) Erect the metal parts security screens forward of the test item. As a minimum, screens should be placed at several locations: as close to the muzzle as feasible (normally 10 to 15 feet - 3 to 4-1/2 meters) to contain muzzle blast, immediately before each velocity screen, and at 100 and 200 feet (30-1/2 and 61 meters) forward of the weapon. Each screen will contain a hole at the center large enough to permit the passage of the projectile without contact. The suggested size of the hole five times the expected dispersion of the weapon of the range where the screen is placed. Additional screens may be placed at intermediate distances of investigation.

(5) Place a witness screen to enshroud the weapon in the area in which a gunner's face would be located, and in any nearby areas expected to be occupied by other personnel or equipment.

(6) Install projectile velocity measuring equipment as described in TOP 4-2-805.

(7) Set up protective armor plate shields or suitable protective shelters (bombproofs) for the protection of personnel during remote firing.

b. Remotely fire each test weapon using cartridges with inert projectiles as follows:

(1) For each test item, singly load and singly fire a minimum of five rounds.

(2) For semiautomatic test items, load with 10 rounds and fire remotely in the semiautomatic mode as rapidly as possible.

(3) For shoulder-fired automatic test items, load with 20 rounds and fire remotely.

(4) For mounted automatic test items, load with 50 rounds and fire remotely.

c. Inspect the weapon and the witness screens for metal parts security after firing each round or group of rounds as applicable.

d. Repeat the firing and inspection in paragraphs b and c above with each type of ammunition that is scheduled for use either during development tests or operational tests. Observe tracer functioning when applicable and record test item load (single, clip, belt-fed) and mode of fire.

5.1.2 Data Required. Record the following for each round fired:

a. Type of projectile (inert, specific type of ammunition).

b. Type of load (single, clip, belt-fed).

c. Mode of firing (single, semiautomatic, automatic).

d. Measured projectile velocities.

e. Damage to the test item and safety hazards observed.

f. Evidence of parts separation or particle deflection as determined from an examination of the metal parts security and witness screens.

g. Results of observations concerning projectile functioning.

5.2 Limited Cook-Off Test. Conduct the following test remotely to determine whether the most severe firing schedule to be employed in operational tests can result in cartridge cook-off and whether the temperatures induced by such firing are likely to cause structural failure of the weapon components.

5.2.1 Method.

a. Determine as nearly as possible, either through consultation with the operational test project officer or by review of the operational test plan, the maximum number of rounds that can or will be fired between occasions of weapon cooling.

b. Instrument the test item for temperature data by installing thermocouples on the exterior of the muzzle device or on the barrel at the muzzle (if no muzzle device is present); on the exterior of the barrel immediately over the chamber mouth; and on the exterior of the barrel proper at the point of the smallest outside diameter.

c. Conduct a firing exercise using 25 percent more rounds than the maximum estimated number of operational test rounds within a time period at least 25 percent less than that planned for the operational test. Fire the exercise with the weapon and ammunition initially conditioned to equilibrium with a free air temperature of 73° ± 2.5° F (23° ± 1.4° C). (If the conditions during subsequent testing are expected to exceed this level, the limited cook-off test should be conducted at the most severe condition expected.)

d. After chambering the final round and closing the bolt, wait 30 minutes. If the round fails to cook off, fire it immediately, using a lanyard or other remote triggering device.

NOTE: When weapons of open-bolt design are to be fired, modify the last round to permit bolt closure without firing. Remove any modified rounds that fail to cook off, place them in suitable metal containers, and mark for destruction.

e. If the round fails to cook off, repeat the test for five trials.

f. If a round cooks off, repeat the entire test using fewer rounds or a less severe firing schedule, to establish the maximum firing rate after which no cook-off will occur.

5.2.2 Data Required. Record the following:

a. Location of each thermocouple.

b. Number of rounds fired per trial.

c. Time required for round to cook off, when applicable.

d. Thermocouple temperature data.

e. Air temperature and relative humidity.

5.3 Safety Selector Tests.

5.3.1 Method. Perform the following with the test weapon unloaded at all times:

a. Investigate the integrity of the test weapon design with respect to safety.

(1) Place the safety selector in the SAFE position with the test item cocked, and conduct a minimum of 10 dry firing attempts to intentionally override the safety.

(2) Place the safety selector between SAFE and FIRE positions and repeat step (1).

(3) With the safety selector on SAFE pull the trigger, then, without trigger pressure, move the selector to other firing mode positions (automatic, semiautomatic).

b. Determine whether the test weapon will inadvertently fire when jarred or bumped from any direction in the following modes:

(1) With the safety selector in the SAFE position and the weapon cocked.

(2) With the safety selector in the FIRE position and the weapon cocked.

5.3.2 Data Required. Record whether or not the safety can be overriden and whether the weapon can be inadvertently fired.

5.4 Double-Feed Safety Test. Determine whether a hazardous incident can occur due to manually feeding a round into the base of a live round remaining in the chamber from a malfunction; i.e., whether the projectile being fed will strike the primer causing an out-of-battery explosion.

5.4.1 Method.

a. Prepare three primed cartridge cases by removing the projectile and propellant from loaded rounds of ammunition.

b. Chamber a primed cartridge case in the test weapon. Remotely feed live or dummy rounds into the base of the case, by manually charging and releasing the bolt (for closed-bolt-firing weapons) or by releasing the trigger (for open-bolt-firing weapons) 10 times or until the primer is struck and fired.

c. If none of the rounds fed initiates the primer, remove and examine the chambered case to establish where the projectile noses struck to determine the likelihood of the primer's being struck and fired.

d. Repeat the test procedure for each of two additional primed cartridge cases.

5.4.2 Data Required.

a. Record whether or not the projectile of a round being fed can strike or initiate a cartridge primer or a round in the chamber.

b. If primer initiation does not occur, measure the distance from the closest strike to the center of the cartridge base.

5.5 Locking System Integrity Test. Determine whether the weapon can be fired without the bolt or barrel (if quick-change type) being completely or adequately locked.

5.5.1 Method.

a. Prepare three primed cartridge cases by removing the projectile and propellant from loaded rounds of ammunition.

b. For closed-bolt (or breech)-firing weapons, chamber a primed case and slowly close the bolt (or breech) while repeatedly pulling the trigger. When the hammer or striker drops, mark the point and recycle the test until the primer fires. Establish that the weapon was adequately locked at the point where the primer fired. If there is doubt as to the adequacy or percentage of locking, repeat the test, remotely firing a loaded cartridge to determine whether a catastrophic failure can occur.

c. Repeat the test procedure for each of two additional primed cartridge cases.

d. For open-bolt-firing weapons it may be necessary to fabricate mechanical blocks in increments to permit primer impact near the point of bolt locking. Otherwise conduct the test as in b above.

e. If the weapon is provided with a quick-change barrel, conduct a test using a chambered primed case. Attempt to fire with the barrel lock not engaged and partially engaged to determine whether an adequate interlock is present in the design. If the condition appears marginal, fire a loaded round remotely to determine whether a catastrophic failure can occur.

5.5.2 Data Required.

a. Record the maximum distance the bolt or breech is out of battery or closed when primer initiation occurs.

b. Record the maximum distance the barrel lock is out of the locked position when primer initiation occurs.

c. Record and describe damage if catastrophic failure test is conducted.

5.6 Firing Pin Inertial Primer-Indent Test (For Closed-Bolt-Firing Automatic Weapons). Determine the likelihood of premature firing occurring when the bolt closes and the firing pin strikes the primer of the chambered round with sufficient inertial force to fire it.

5.6.1 Method.

a. Prepare five primed cartridge cases by removing the projectile and propellant from loaded rounds of ammunition.

b. Chamber a primed cartridge case. With no other ammunition in the magazine or feedway, allow the bolt to drop from its rearmost position onto the chambered case. If the primer does not fire, repeat the test four more times, replacing the primed case with each trial.

c. If any primers are initiated, remotely fire 10 single rounds with a loaded magazine, employing unmodified ammunition, and examine alternate rounds that have been chambered automatically for significant primer indent.

5.6.2 Data Required.

a. Measure and record the depth of any visible firing pin indents from the head of each cartridge case that did not fire.

b. Record the number of primers initiated by inertial indents.

5.7 Misassembly Test. Determine whether it is possible to assemble the weapon incorrectly so that it can be fired in an unsafe condition.

5.7.1 Method.

a. Prepare three primed cartridge cases by removing the projectile and propellant from loaded rounds of ammunition.

b. Attempt to fire a chambered cartridge case under each of the following conditions:

(1) With the bolt lock(s) (if separate) removed, assembled backwards, incompletely, and with subcomponent(s) missing.

(2) With barrel locks or interlocks (if applicable) removed, assembled incorrectly, incompletely, or with subcomponent(s) missing.

(3) With the firing pin assembled in the bolt in the forward position so that firing could take place when the bolt closes (applicable only to weapon firing from the closed-bolt position).

c. Repeat the test procedure for each of two additional primed cartridge cases.

d. If a judgmental analysis of the weapon under test indicates any other operational situation that may result in a hazard under field conditions, conduct additional remote test firings which simulate the questionable situation to determine whether a catastrophic failure can occur or personnel can be injured.

5.7.2 Data Required.

a. Describe the incorrect assembly modes that permitted cartridge primer initiation.

b. Report whether it is possible to cause any catastrophic failure of the weapon by incorrect assembly.

5.8 Tactical Firing Tests. Conduct tactical firing exercises if no safety hazards are detected during the remote firing and cook-off tests (5.1 and 5.2 above) and, in the opinion of the test director, the gunner would be subject to minimal risks. During live firing exercises, all gunners and adjacent personnel shall wear ear and eye protection equipment.

5.8.1 Method.

a. Install instrumentation to measure sound pressure levels in accordance with TOP/MTP 3-2-811.

b. Conduct firing exercises from tactical firing positions, using the optional weapon firing modes and employing only inert projectiles.

(1) Fire a minimum of 20 rounds for hand-held, single-shot test items.

(2) Fire a minimum of 100 rounds in all other hand-held test items.

(3) Fire a minimum of 500 rounds in mounted weapons.

c. During the firing exercises evaluate the following:

(1) Ability to operate control devices (safety, fire mode selector, magazine release, bolt release, etc.) without difficulty.

(2) Possibility of injury to the hands or fingers of the gunner when removing or inserting magazines, opening or closing feed covers, releasing the bolt, etc.

(3) Possibility of injury during recoil as a result of metal projections at hand-held positions or as a result of contact with moving parts such as operating rods.

NOTE: Observe (4) and (5) below with regard to both left- and right-handed gunners and adjacent personnel, i.e., loaders and assistant gunners.

(4) Adequacy of handguards to prevent contact with the heated barrel.

(5) Direction of the ejection path of expended cartridge cases.

(6) Other human factor problems as observed by the test director.

NOTE: In reporting, evaluate and identify all the optional test item firing modes, weapon attachments, and the various tactical firing positions.

5.8.2 Data Required. Record the following:

a. Mode of firing (single, semiautomatic, automatic).

b. Tactical firing position (prone, standing, kneeling, etc.).

c. Attachment employed (winter trigger kit, bipod, machine gun with shoulder stock and bipod, etc.).

d. Difficulties experienced during operation of control devices.

e. Potential injuries to the gunner when operating the weapon.

f. Adequacy of the handguards.

g. Adequacy of the ejection path of the expended cartridge cases.

h. Other human factor problems as observed by the test director.

i. Sound pressure level as described in TOP/MTP 3-2-811.

j. Cartridge headspace before and after each firing exercise.

5.9 Environmental Testing. Unless otherwise directed, perform environmental testing during the safety evaluation if the test weapon is to be subject to nontemperate weather conditions (i.e., tropic, desert, arctic) during operational tests.

5.9.1 Method.

a. Condition the test item and ammunition for a minimum of 24 hours to the applicable extreme temperature(s) of AR 70-38 3/ as interpreted in table 2.

Table 2 - Extreme Temperatures

Climatic Category of AR 70-38	Temperature	
	°F	°C
Hot-dry	*160	*71.1
Intermediate hot-dry	*145	*62.8
Intermediate cold	-35	-37.2
Cold	-50	-45.5
Extreme cold	-60	-51.1

*Takes into account heating effects due to solar radiation. 4/

b. Fire the test weapon at the conditioned temperature(s) in accordance with the tactical firing test procedure of paragraph 5.8, which may be preceded by the preliminary functional firing test procedure of paragraph 5.1 if test results observed so far indicate that this is required to assure operator safety. The extreme temperature safety testing may be accomplished in conjunction with more extensive performance firings.

c. After firing, inspect the test item for the following as applicable:

(1) Cracks, using the magnetic particle inspection process as described in TOP/MTP 3-2-807.

(2) Rust and deterioration.

5.9.2 Data Required. Record the following as applicable:

a. Test temperatures.

3/ AR 70-38, Research, Development, Test, and Evaluation of Materiel for Extreme Climatic Conditions.

4/ Final Report of Study to Determine High-Temperature Test Procedures for Selected Infantry Weapons to Satisfy AR 705-15, Aberdeen Proving Ground, MD, Report DPS-1692, October 1965.

b. Relative humidity.

c. Results of magnetic particle inspection.

d. Firing data as specified in paragraph 5.1.2.

5.10 Post-Test Inspections.

5.10.1 Method. Upon completion of all preliminary safety evaluation tests, and again after all performance and reliability tests, perform the following:

a. Disassemble the test item and visually examine all major components.

b. Conduct a magnetic particle inspection of components as described in TOP/MTP 3-2-807.

c. Inspect all fired cases for signs of stretching, punctured primers, sheared or punched out rims, and other deformations.

5.10.2 Data Required. Record the results of the visual and magnetic particle inspections.

6. DATA REDUCTION AND PRESENTATION.

a. Tabulate all data and compare these data with established criteria.

b. Based on data recorded during preliminary safety tests, prepare a safety release recommendation for submittal to TECOM. Detailed results of the test need not be included, but a statement similar to one of the following is made:

(1) "No undue hazards beyond those normally associated with the firing of similar weapons were detected as a result of safety evaluation tests, and the subject weapon is considered safe for purposes of further testing provided the following restrictions are observed" (list the restrictions).

(2) "The subject weapon cannot be considered safe for further testing due to the following safety hazards encountered in tests" (list the safety hazards).

c. Assemble and tabulate all results and safety information generated during the preliminary safety tests conducted in accordance with this TOP and the performance tests conducted as described in TOP 3-2-059. Assign the proper category of hazard level for each hazard identified. Report hazard level 5/ and classification (deficiency, shortcoming, etc.) in accordance with DARCOM-R 700-38 (para 4f) and TECOM Supplement 1. 6/ Report the conditions of use under which each hazard was observed and describe any features that require further investigation, including any hazards that could occur or increase as a result of increased operating hours. Describe (narratively) all safety hazards identified and recommend actions required to eliminate or avoid each potential hazard.

Recommended changes to this publication should be forwarded to Commander, U. S. Army Test and Evaluation Command, ATTN: DRSTE-ME, Aberdeen Proving Ground, Md. 21005. Technical information may be obtained from the preparing activity: Commander, U. S. Army Aberdeen Proving Ground, ATTN: STEAP-MT-M, Aberdeen Proving Ground, Md. 21005. Additional copies are available from the Defense Documentation Center, Cameron Station, Alexandria, Va. 22314. This document is identified by the accession number (AD No.) printed on the first page.

5/ MIL-STD-882, System Safety Program for Systems and Associated Subsystems and Equipment, Requirements for.

6/ DARCOM-R 700-38, with TECOM Suppl 1, Test and Evaluation - Incidents Disclosed During Materiel Testing.